

REMARKS

Claims 21-25, 27-36 and 38-45, all the claims pending in the application, stand rejected. Claims 21, 31, 39, 42 and 43 are amended. New claims 46 and 47 are added.

The amendments to independent claims 21, 31, 39 and 43 are based on the descriptions on page 11, lines 25 to 27; page 19, lines 10 to 13; and page 22, lines 4 to 6 of the original specification. The amendment to claim 42 is to correct an inadvertent typographical error. The content of new claim 46 is based upon the descriptions on page 11, lines 25 to 27; page 19, lines 10 to 13; and page 22, lines 4 to 6 of the original specification and the illustrations in Figs. 2-4. The content of new claim 47 is based upon the text regarding radical density, as taught at pages 10, 19 and 22.

Response to Amendment

In the Examiner's comment with regard to the declaration under 37 CFR 1.132 filed June 16, 2008, the Examiner finds the declaration to be "insufficient to overcome the rejections based upon Kwon as set forth in the last Office action because: the evidence therein and the accompanying arguments are not commensurate with the scope of the claim language." Applicants respectfully submit that the Examiner has misinterpreted the purpose of the declaration and respectfully requests reconsideration.

Declaration Is Intended to Demonstrate Inadequate Disclosure of Prior Art

Applicant has submitted the Kimura Declaration in order to demonstrate that the teachings of the prior art are insufficient or ambiguous. Applicants respectfully submit that this purpose is not related to the consistency with the claim language. Applicants further submit that the Kimura Declaration clearly demonstrates that the teachings in Kwon are inadequate to teach the key limitations of the claim.

The Kimura Declaration is NOT intended to provide support for the operability or enablement of the claimed invention. Thus, there is no need to consider the scope of the claim, other than the express language referenced in the Declaration.

Applicants respectfully request an interview with the Examiner, once this amendment has been entered, to discuss this important issue and the patentability of the invention over the prior art.

The Declaration Expressly Addresses the Key Claim Limitations

Applicants respectfully submit that the Kimura Declaration also demonstrates that the disclosure in the Kwon reference is *insufficient to show* the claimed feature that “the plasma excitation power is lower than a plasma excitation power at which a plasma density jump occurs so that verticalness of the sectional shape of the pattern formed in the thin film is enhanced.” There are no other features addressed, thus other claim language need not be mentioned.

In this regard, the Declaration expressly demonstrates that (1) multiple factors determine the power at which plasma density jump occurs, including (a) source power actually supplied to the plasma, (b) plasma generating volume, (c) gas pressure, (d) internal structure of the chamber, and (e) gas composition parameters, (2) Kwon only teaches a power value of 10-250W (3) Kwon does not teach or suggest etching at a power level below that which causes a plasma density jump.

The Declaration Also Demonstrates That Kwon Teaches Away

At paragraph 8) of the Kimura Declaration, it is demonstrated that Kwon teaches away from the presence of any plasma density jump, due to (a) the absence of any disclosure of other relevant parameters and (b) the illustration in Fig. 2(a) of Kwon where the linearity of the etching rate of Cr demonstrates that there is no plasma density jump since a jump would result in a non-linearity.

Claims Positively Recite a Setting Step

The Examiner states that “the recitation in claim 21 pertaining to plasma density is contained within a wherein clause and therefore does not limit the claim (see MPEP 2106).” The Examiner suggests using a positive recitation, such as “setting the power to a level such that...”. This suggestion has been adopted. Further, in new claims 46 and 47, structural features have been added that are consistent with the Kimura Declaration.

Claim Rejections - 35 USC § 102

Claims 21, 22, 31, 32, 36, 38-40, 42 and 43 are rejected under 35 U.S.C. 102(b) as being anticipated by Kwon et al. in Loading Effect Parameters at Dry Etcher System and Their Analysis at Mask-to-Mask Loading and Within-Mask Loading, SPIE Vol. 4562 pp. 79-87 (hereinafter, Kwon).

Applicants respectfully note that the Examiner has now repeated the identical text provided in the rejection dated November 15, 2008 and has added only the comment regarding the Kimura Declaration in the Response to Arguments. As noted above, the Kimura Declaration is pertinent and comprehensive in demonstrating that the teachings in Kwon are insufficient and ambiguous. Moreover, the arguments presented previously continue to be relevant and are incorporated by reference.

Kwon

In addition, Applicants wish to further stress that Kwon has no consideration or teaching with respect to decreasing a plasma density and a radical density.

While the Examiner may find similarities between Kwon and the present invention with respect to etching a Cr photomask using an ICP, Cl₂, O₂ together with the use of an organic resist, a photoresist coverage, photoresist etch selectivity and some other parameters, there is a disclosure in Kwon that a Cr etch rate is increased by increasing source power, as shown in Fig. 2(a).

Given the conventional understanding in the art, namely, that lowering the plasma excitation power less than that of the electron density jump could not be used to etch the Cr and the photoresist due to an instability of plasma, as mentioned on page 10, lines 20 to 21 of the instant specification, there is no basis for moving in the direction as claimed.

One of ordinary skill would know that photoresist etch rates increase at source power below 200 W and saturate at source power over than 200W (page 81, lines 7 to 4 from the bottom). Also, it would be readily understood that both the ions and the radicals are used to etch Cr and the photoresist.

However, there is no consideration at all in Kwon et al or the conventional art about decreasing a plasma density and a radical density. Moreover, neither Kwon et al nor the conventional art are aware of a claimed phenomenon of a plasma density jump, especially, an electron density jump. Although a phenomenon of such an electron density jump itself is known in the art, as discussed in the preamble of the original specification in connection with the second prior art, the gist of the present invention, based upon the discovery that an amount of radicals should be controlled so as to suppress promotion of the isotropic etching (see page 10, lines 22 to 23; page 11, lines 3 to 5), was not known. In other words, the present application first teaches to suppress radicals in plasma and to avoid isotropic etching.

To this end, the present invention comprises a step of setting a plasma excitation power to a value smaller than a plasma excitation power at which plasma excitation jump takes place, as mentioned above. Nothing is taught by Kwon et al about suppressing radicals and lowering the plasma excitation power to a value at which the electron density jump takes place. Claim 47 expressly states this feature.

Claims 31, 39 and 43

Amendments similar to those made to claim 21 have been made to independent claims 31, 39 and 43. Thus, these claims should be patentable for the reasons given for claim 21.

Claims 22, 32, 36, and 38-40

These claims, which depend from parent claims discussed above, would be patentable for reasons given for their parent claims.

Taking the above into consideration, Applicants respectfully submit that the present invention as defined in amended claim 21 is not obvious from Kwon, Stoer et al, and any other cited art, and is therefore patentable over them.

Claims 21,23, 31, 39 and 43 are rejected under 35 U.S.C. 102(b) as being anticipated by Stoer et al. in WO 01/96955 (hereinafter, Stoer). This rejection is traversed for at least the following reasons.

Stoer et al

The Examiner asserts that Stoer et al teaches etching a Cr-based, thin-film photomask using ICP and an etchant comprising Cl₂, O₂ and He, as well as etching Cr, in the presence of a polymeric organic photoresist (page 17). The Examiner notes that Stoer et al teaches using low plasma excitation power, specifically “700 W of power or less (see page 5). As such Stoer teaches a power range that includes the minimum power required to produce a plasma and therefore is considered to etch at a power level below that which causes a jump in plasma density.”

As with Kwon, there is not teaching or suggestion in Stoer et al that for the specific plasma chamber, the specific gas and gas pressure and the specific power level, there would be a step of “setting a plasma excitation power to a value lower than a power value at which electron density jump is caused to occur.” Stoer et al has no hint that this critical feature would be considered in the design and implementation of the disclosed system or process.

Thus the claims would not be anticipated by Stoer et al.

Claim Rejections - 35 USC § 103

Claims 23-25, 27, 28, 30, 44 and 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kwon, as applied above to claims 28 and 39, in view of Oh et al. in Proc. SPIE Vol. 4186, pp. 532-539, Dry Etching Technology of Cr and MoSi Layers Using High-Density Plasma Source (hereinafter, Oh). This rejection is traversed for at least the following reasons.

Claims 23-25, 30, 44 and 45

These dependent claims would be patentable for the reasons given for their parent claims, as discussed above.

Further, the Examiner admits that Kwon does not teach biasing the substrate by applying a high frequency power. The Examiner cites Oh for “additional details regarding the apparatus that is used by Kwon (see line 1 on page 81 of Kwon and Kwon's reference 5).” In particular, Oh is cited for showing that the DC bias that is disclosed by Kwon is controlled by the power

level of an RF bias and that 10-15 W of RF bias power can be applied while applying 150-200 W of plasma excitation power.

However, this teaching does not mention any consideration of setting an excitation power value with regard to plasma jump or the suppression of radicals in order to avoid isotropic etching.

Claims 27 and 28

Claim 27 depends from claim 21 and would be patentable for reasons given for the parent claim.

Furthermore, helium is added to a dry etching gas in order to generate stable plasma even when the plasma excitation power is lowered, as explicitly claimed in Claim 27.

Claim 28 would be patentable because it depends from claim 27.

Claim 29 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kwon in view of Oh, as applied above to claims 28, in view of US Patent 4,613,401 issued to Hoshino and further in view of US Patent 6,913,706 issued to Yan et al. (hereinafter, Yan). This rejection is traversed for at least the following reasons.

Claim 29

This dependent claim would be patentable for the reasons given for its parent claims 21, 27 and 28, as discussed above.

Further, the Examiner admits that Kwon and Oh do not teach adding an organic gas to the etchant. The Examiner cites Hoshino for a teaching of adding ethanol vapor to a plasma etching gas when etching Cr, and cites Yan for a teaching that chromium-oxychloride is produced when Cr is plasma etched with Cl₂ and O₂.

Since Yan and Hoshino do not remedy the deficiencies of Kwon and Oh, the claims would be patentable.

Claims 33-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kwon, as applied above to claim 32, in view of US Patent 4,613,401 issued to Hoshino and further in view of Yan. This rejection is traversed for at least the following reasons.

Claims 33-35

These dependent claims would be patentable for the reasons given for their parent claims 31 and 32, as discussed above.

Further, the Examiner admits that Kwon does not teach adding an organic gas to the etchant and looks to Hoshino for a teaching of adding ethanol vapor to a plasma etching gas when etching C and to Yan for a teaching that chromium-oxychloride is produced when Cr is plasma etched with Cl₂ and O₂.

Since Yan and Hoshino do not remedy the deficiencies of Kwon and Oh, the claims would be patentable.

Claim 41 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kwon, as applied above to claim 40, in view of US Patent 6,989,603 issued to Zhang. This rejection is traversed for at least the following reasons.

Claim 41

This dependent claim would be patentable for the reasons given for their parent claim 39, as discussed above.

Further, the Examiner admits that Kwon does not teach a mask comprising an optical proximity correction pattern. The Examiner looks to Zhang for a teaching of masks comprising an optical proximity correction pattern.

Since Zhang does not remedy the deficiencies of Kwon, the claims would be patentable for the reasons already given..

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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23373

CUSTOMER NUMBER

Date: April 13, 2009

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